

A N D H R A U N I V E R S I T Y



M.Sc. DEGREE EXAMINATION IN ZOOLOGY - SYLLABUS (Effect from 2007-2008 Batch)

1. Candidates for M.Sc. Zoology Degree examination shall be required : (a) To have passed the qualifying examination of this University as detailed in AUCET (Andhra University Common Entrance Test) regulations or an examination of any other University recognized by the Academic Council as equivalent thereto; and (b) To have undergone subsequently a further course of studies extending over a period of two academic years. As the case may be, in this University, each academic year consisting of two semesters ordinarily consecutive.

2. The course and scope of instruction shall be defined in the syllabus prescribed :

3. (a) The candidate shall be required to take at the end of each semester, an examination as detailed in the scheme of examination. Each paper of the examination shall unless otherwise prescribed be of three hours duration and for a maximum of 100 marks (15 + 85). An external papersetter shall set the question paper. There shall be double valuation. Similarly, there shall be one semester-end examination of 2-3 hours duration in each practical course. Paper-setting and evaluation shall be done jointly by two examiners, one internal and one external. Evaluation of the performance of the

candidates in respect of each paper shall be carried out only by the semester-end examination.

(b) A candidate appearing for the whole examination shall be declared to have passed the examination if he/she obtains not less than 50% of the total marks in all papers including practical and records put together. And, also not less than 40% in each paper/practical at the semester-end and 40% marks for a maximum of 100 marks for each paper. All other candidates shall be deemed to have failed in the examination. Candidates who have completed the first semester course and have earned the necessary attendance and progress certificate shall be permitted to continue the second semester course irrespective of whether they have appeared or not at the first semester examination. Such candidates may be permitted to appear for the examination of the earlier semester with the examination of the later semester simultaneously.

Candidates shall put in attendance at the college for not less than 75% of the total number of working days. Condonation of shortage of attendance may be granted on the recommendation of the Principal of the College concerned provided that no condonation shall be recommended in the case of candidates who have not put in attendance at the college for at least 50% of the total number of working days. If a candidate represents the University officially at games, sports or other officially organized extra curricular activities, it will be deemed that he/she has attended the college on the days he/she is absent for the purpose.

4. The names of the successful candidates at the examination shall be arranged in order in which they are registered for the examination as follows. On the basis of the total marks obtained by the each candidate at the I-IV Semester-end examination put together.

I Class with Distinction : Those who obtain 70% and above I Class

I Class : Those who obtain 60% and above but less than 70%

II Class : Those who obtain 50% and above but less than 60%

Only those candidates who appear and pass examination in all the papers of the four semesters at first appearance are eligible to be placed in the first class with distinction. However, no candidate who has not passed all the papers relating to any semester at the first appearance shall be eligible for any medals, or prizes by the University and to receive certificates of rank, obtained by them in the examination.

Marks Schedule for Each Semester

Semester Duration : 16 weeks (Excluding holidays and time for Semester-end examination)

Theory : Number of periods of theory per paper : 4 – 5 periods per week. Each period of 50 minutes duration.

Practical : Students will be distributed into 4 – 5 batches per practical. Each practical class shall be of 3 periods (3 x 50 minutes) duration/batch.

Scheme of Examination

Title of the Paper	Marks allocated
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	Mid- Sem.	Sem. End	Total
I Semester			
1. Biosystematics and Taxonomy	15	85	100
2. Quantitative Biology	15	85	100
3. General and Comparative Physiology	15	85	100
4. Molecular Cell Biology	15	85	100
5. Laboratory Course (4 Practical Courses each for 50 marks)	--	--	200
6. Seminar	--	--	50
II Semester			
7. Population Genetics and Evolution			100
8. Gamete Biology		85	100
9. Tools and Techniques for Biology	15	85	100
10. General and Comparative Endocrinology.	15	85	100
11. Laboratory Courses (4 Practical Courses , each for 50 marks)	15	--	200
12. Viva-voce	--		50
	--	--	
III Semester			
A - Stream			
13. Structure and Functions of Invertebrates	15	85	100
14. Comparative Anatomy of Vertebrates	15	85	100
15. Population Ecology	15	85	100
16. Animal Behaviour	--	--	200
17. Laboratory Courses (4 Practical Courses , each for 50 marks)			
18. Seminar	--	--	50
B – Stream			
		85	100

	15	85	100
19. Biology of Vertebrate Immune System	15	85	100
	15	85	100
20. Genes and Differentiation	15	--	200
21. Molecular Cytogenetics	--	--	50
22. Molecular Biology	--		
23. Laboratory Course			
24. Seminar			
IV Semester			
		85	100
Electives : A – Stream			
(Four electives to be selected by each student)	15	85	100
	15	85	100
	15	85	100
1. Coastal and Marine Biodiversity	15	85	100
2. Biological Oceanography	15	85	100
3. Marine Biology	15	85	100
4. Limnology	15	85	100
5. Ichthyology	15	85	100
6. Capture Fisheries	15	85	100
7. Aquaculture	15	85	100
8. Wild Life & Conservation Biology	15	--	200
9. Medical Parasitology	--		
10. Veterinary Parasitology	--	--	
11. Principles of Immunology	--		50
12. Laboratory Course (4 Practical Courses each for 50 marks)			
13. Viva-voce			
Electives : B – Stream			
(Four electives to be selected by each student)			
	15	85	100
1. Metabolic Cell Function and Regulations	15	85	100
	15	85	100
2. Environmental Physiology	15	85	100
3. Principles of Biotechnology	15	85	100
4. Toxicology	15	85	100
5. Applied Immunology	15	85	100
6. Medical Microbiology	15	85	100
7. Haematology	--	--	200
8. General & Systemic Pathology			
9. Laboratory Course (4 Practical Courses each for 50 marks)	--	--	
			50
10. Viva-voce			

Course Structure and Scheme of Examination

- The degree shall be called M.Sc. (Zoology)
- The course shall be based on semester system. The recommended duration is 4 Semesters
- A student shall have to take the suggested courses for the first two semesters. In the 3rd Semester they have to choose four courses either from Stream 'A' or 'B' along with the laboratory courses and seminars. In the final semester, i.e., 4th Semester, a student from 'A' Stream shall have to select four electives prescribed for 'A' Stream. Similarly, 'B' stream students shall have to select four electives prescribed under 'B' Stream. Each paper shall carry four to five hours of contact period between teacher and taught per every week for 12 weeks. This amounts to 48 lectures duration of 50 minutes each.
- Admission shall be based on entrance examination
- Laboratory courses/practical shall be chosen from the list suggested for first year or for first two semesters
- Practical examinations shall be conducted for 1st and 2nd Semesters together at the end of the 1st year or at the end of the 2nd Semester
- In the II year of the M.Sc. course, practical examination shall be conducted semester-wise, i.e., at the end of 3rd and 4th Semesters respectively
- In the present curriculum, it is resolved to award marks while evaluating the student. Each course (theory) shall be evaluated for 100 marks. Practical examination for 50 marks and seminars/Viva-voce for 50 marks
- Total maximum marks for evaluation in all (1st, 2nd, 3rd, 4th) semesters are 2600 (i.e., 650 marks for each semester). The candidate should obtain a minimum of 50% to qualify for the degree

Paper-setting shall be by external examiner

Evaluation of theory and practical by both external and internal examiners

Seminar evaluation is by a committee or internal examiner

- On the basis of total marks obtained by each candidate at the end of all semester-end examinations put together, they will be awarded

First class with distinction : those who obtain 70% and above

First Class : Those who obtain 60% and above but less than 70%

Second Class : Those who obtain 50% and above but less than 60%

SYLLABUS – I SEMESTER

1. BIOSYSTEMATICS & TAXONOMY

Unit – I :

- 1.0. Definition and basic concepts of biosystematics and taxonomy
 - 1.1. Histological resume of systematics
 - 1.2. Importance and applications of biosystematics in biology
 - 1.3. Material basis of biosystematics – different attributes

Unit – II :

- 2.0. Trends in biosystematics – concepts of different conventional and newer aspects
 - 2.1. Chemotaxonomy
 - 2.2. Cytotaxonomy
 - 2.3. Molecular taxonomy
- 3.0. Molecular perspective on the conservation of diversity
 - 3.1. Diversity and ecosystem process: Theory, achievements and future directions

Unit – III :

- 4.0. Dimensions of speciation and taxonomy characters
 - 4.1. Dimensions of speciation- types of lineage changes, production of additional lineage
 - 4.2. Mechanisms of speciation in panmictic and apomictic species
 - 4.3. Species concepts – species category, different species concepts: sub-species and other infra specific categories
 - 4.4. Theories of biological classification, hierarchy of categories
 - 4.5. Taxonomic characters – different kinds, origin of reproductive isolation – biological mechanism of genetic incompatibility

Unit – IV :

- 5.0. Procedure keys in taxonomy
- 5.1. Taxonomic procedures – taxonomic collections, preservation, curation process of identification
- 5.2. Taxonomic keys – different kinds of taxonomic keys, their merits and demerits
- 5.3. Systematic publications – different kinds of publications
- 5.4. Process of typification and different Zoological types
- 5.5. International Code of Zoological Nomenclature (ICZN) – its operative principles, interpretation and application of important rules, Zoological nomenclature, formation of scientific names of various taxa

Practical :

- 1. A practical approach towards Biosystematics and taxonomy
- 2. Examples representing the different taxa in the order of evolution
- 3. Molecular perspective of diversity – Identification of species by molecular separation of proteins by examples
- 4. Diversity and similarity index.
- 5. Methods of collection, preservation and identification of plankton and representative forms of terrestrial and aquatic fauna

Suggested Reading Material :

- 1. M. Kato. The Biology of Biodiversity, Springer.
- 2. J.C. Avise. Molecular Markers. Natural History and Evolution, Chapman & Hall, New York.
- 3. E.O. Wilson. Biodiversity, Academic Press, Washington.

4. G.G. Simpson. Principle of Animal Taxonomy. Oxford IBH Pub. Co.
5. E. Mayer. Elements of Taxonomy.
6. E.O. Wilson. The Diversity of Life (The College Edition), W.W. Northern & Co.
7. B.K. Tikadar. Threatened Animals of India, ZSI Publication, Calcutta.

2. QUANTITATIVE BIOLOGY

Unit – I : Biostatistics

1. Introduction – Scope and application of statistics in Biology
2. Sampling – Essentials, advantages and methods of sampling and sampling errors
3. Frequency distribution : Preparation of ordered, discrete and continuous tables
4. Diagrammatic presentation of data : Data presentation by diagrams, graphs and curves
5. Skewness and Kurtosis

Unit – II :

6. Measures of central tendency : Mean, median and mode
7. Measures of dispersion : Standard deviation, variance and coefficient of variance
8. Correlation and regression

Unit – III :

9. Probability : Measurement, terminology, laws
10. Probability distributions : Binomial, Poisson and normal distributions
11. Tests of significance : Chi-square test, t-test
12. Analysis of variance

Unit – IV :

13. Fundamentals of computers – Hardware and Software
14. Computer-aided techniques for data presentation, data analysis and statistical techniques – Excel
15. Mathematical modeling – Types of models, building of a model
16. Examples of models from Biology : Growth of snail shell, morphogenesis

Practical :

1. Vectors and Matrices - Problems
2. Sampling – Lottery method and Random digits
3. Frequency distribution
4. Graphical presentation of the data
5. Measures of Central Tendency – Mean, median and mode
6. Measures of Dispersion – S.D. & C.V. (Standard deviation and Coefficient of variation)
7. Probability
8. Coefficient of Correlation
9. Circuit diagram – Examples of models
10. Ecological modeling – Case study

Suggested Reading Material :

1. Batschelet, E., Introduction to Mathematics for Life Scientists. Springer-Verlag, Berlin.
2. Jorgensen, S.E., Fundamentals of Ecological Modelling, Elsevier, New York.
3. Swaritzman, G.L. and S.P.O. Kaluzny. Ecological Simulation Primer Macmillan, New York.
4. Lendren, D. Modeling in Behavioural Ecology. Chapman & Hal. London, UK
5. Sokal, R.R. & F.J. Rohlf. Biometry. Freeman, San Francisco.
6. Snedecor, G.W. and W.G. Cochran, Statistical methods for environmental biologists. John Wiley & Sons, New York.
7. Murray, J.D. Mathematical Biology. Springer – Verlag, Berlin.
8. Pielou, E.C. The Interpretation of Ecological Data. A Primer on Classification and Ordination.

3. GENERAL AND COMPARATIVE PHYSIOLOGY

Unit – I :

1.0. Muscle : Historical background

- 1.1. Types of muscles and classification
- 1.2. Light and Electron microscopic structure of skeletal muscle
- 1.3. Molecular basis of muscle contraction, Sliding filament theory
- 1.4. Energetics and thermal aspects of muscle contractions
- 1.5. Twitch, Summation, Tetanus and Fatigue

2.0. Nerve : Structure of the nerve, Excitability, conductivity, Refractory period, summation, Chronoxie and Rheobase, All or None principle

- 2.1. Nerve Impulse, Ionic basis of resting and action potentials
- 2.2. Synaptic transmission, Neurotransmitters

Unit – II :

3.0. Blood : Structure and properties of Blood

- 3.1. Blood cells and their origin, haemopoises, hemoglobin, functions of erythrocytes and leucocytes
- 3.2. Blood coagulation – Factors affecting coagulation

4.0. Defense mechanism :

- 4.1. Reticulo Endothelial system : Macro phages, Lymphocytes
- 4.2. Immunoglobulins, origin, properties and functions
- 4.3. Humoral Immunity and Cell- Mediated Immunity
- 4.4. Primary and secondary immune mechanisms
- 4.5. Blood groups and tissue antigens

Unit – III :

5.0. Physiological adaptation of animals to different environments

- 5.1. Marine environment
- 5.2. Shores and Estuaries

- 5.3. Freshwater environment
- 5.4. Extreme aquatic environment
- 5.5. Terrestrial life
- 5.6. Extreme terrestrial environment
- 5.7. Parasitic habitats

6.0. Stress Physiology

- 6.1. Basic concept of environmental stress and strain, concepts of elastic and plastic strain; stress resistance, stress avoidance and stress tolerance
- 6.2. Adaptation, Acclimation and Acclimatization

Unit – IV :

7.0. Concept of homeostasis and homeostatic mechanisms of the body

- 7.1. Thermoregulation, Exothermic and Endothermic organisms
- 7.2. Endothermy and physiological mechanism of body temperature regulation

8.0. Physiological adaptation to osmotic and ionic stress; mechanism of cell volume regulation

- 8.1. Osmoregulation in aqueous and terrestrial environments
- 8.2. Physiological response to oxygen deficient stress
- 8.3. Physiological response to body exercise
- 8.4. Meditation, Yoga and their effects

Practical :

1. Oxygen consumption Vs. temperature
2. Estimation of Urea, Ammonia, etc.
3. Calculation of Q_{10} values
4. Determination of digestive enzymes
5. *Trichiurus* laterline sense organs
6. Demonstration of chromatophore
7. Osmotic regulation – Earthworm experiments

Suggested Reading Material :

1. C.L. Prosser, Comparative Animal Physiology. W.B. Saunders & Company
2. R. Eckert. Animal Physiology: Mechanisms and Adaptation. W.H. Freeman & Company
3. Hoar, W.S. General and comparative Animal Physiology. Prentice Hall of India.
4. Schiemdt Nielsen. Animal Physiology. Adaptation and Environment, Cambridge.
5. Strand, F.L. Physiology : A regulatory systems approach. Macmillan Publishing Co., New York.
6. Prosser, C.L., environmental and Metabolic Animal Physiology. Wiley-Liss Inc., New York.

4. MOLECULAR CELL BIOLOGY

Unit – I :

- 1.0. Introduction : Experimental system in Cell Biology
- 2.0. Biomembranes
 - 2.1. Molecular composition and arrangement, functional consequences
 - 2.2. Transport across cell membrane: diffusion, active transport and pumps, uniports, symports and antiports
 - 2.3. Membrane potential
 - 2.4. Co-transport by symporters or antiports
 - 2.5. Transport across epithelia: Transport of macromolecules

Unit – II :

- 3.0. Cytoskeleton
 - 3.1. Microfilaments and microtubules – structure and dynamics
 - 3.2. Microtubules and mitosis
 - 3.3. Cilia and flagella
 - 3.4. Cell movements – intracellular transport, role and kinesin and dynein, signal transduction mechanisms

Unit – III :

- 5.0. Cell-Cell Signaling
 - 5.1. Cell surface receptors
 - 5.2. Second messenger system
 - 5.3. MAP kinase pathways
 - 5.4. Apoptosis: Definition, mechanism and significance
- 6.0. Cell-Cell adhesion and communication
 - 6.1. Ca^{++} dependent homophilic cell-cell adhesion

- 6.2. Ca^{++} independent homophillic adhesion
- 6.3. Gap junctions and connections
- 6.4. Integrins
- 6.5. Collagen

Unit – IV :

7.0. Cell cycle

- 7.1. Cyclines and cyclin dependent kinases
- 7.2. Regulation of CDK-cycline activity

8.0. Genome organization

- 8.1. Hierarchy in organization
- 8.2. Chromosomal organization of genes and non-coding DNA
- 8.3. Mobile DNA
- 8.4. Morphological and functional elements of eukaryotic chromosomes

9.0. Intracellular protein traffic

- 9.1. Protein synthesis on free and bound polysomes
- 9.2. Uptake into ER
- 9.3. Membrane proteins, Golgi sorting, post-translational modifications
- 9.4. Biogenesis of mitochondria and nuclei
- 9.5. Trafficking mechanisms

Practical :

- 1. Light microscopic examination of tissues
- 2. Preparation of different cell – types Hepatic parenchymal cells, adipocytes, macrophages, neuronal cells, epithelial cells
- 3. Stages of Mitosis and Meiosis
- 4. Squash preparation
- 5. Sub-cellular fractionation – separation of macromolecules

Suggested Reading Material :

1. Molecular Cell Biology, J. Darnell, H. Lodish and D. Baltimore, Scientific American Book INC, USA.
2. Molecular Biology of the Cell, B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson Garland Publishing INC, New York.

II SEMESTER

5. POPULATION GENETICS AND EVOLUTION

Unit – I :

- 1.0. Concepts of evolution and theories of organic evolution with emphasis on Darwinism
- 2.0. Neo-Darwinism
 - 2.1. Hardy Weinberg law of genetic equilibrium
 - 2.2. A detailed account of destabilizing forces - (i) natural selection (ii) Mutation (iii) Migration (iv) Genetic drift

Unit – II :

- 3.0. Quantifying genetic variability
 - 3.1. Genetic structure of natural populations
 - 3.2. Phenotypic variation
 - 3.3. Factors affecting human diseases frequency
- 4.0. Genetics of quantitative traits in populations
 - 4.1. Analysis of quantitative traits
 - 4.2. Quantitative traits and natural selection
 - 4.3. Estimation or heritability
 - 4.4. Genotype – environment interactions
 - 4.5. Inbreeding, depression and Heterosis

Unit – III :

- 5.0. Genetics of speciation
 - 5.1. Phylogenetic and biological concept of species
 - 5.2. Patterns and mechanisms of reproductive isolation
 - 5.3. Models of speciation (Allopatric, Sympatric, Parapatric)
- 6.0. Molecular evolution
 - 6.1. Gene evolution
 - 6.2. Evolution of gene families, Molecular drive

Unit – IV :

7.0. Origin of higher categories

- 7.1. Phylogenetic gradualism and punctuated equilibrium
- 7.2. Micro- and macro-evolution

8.0. Molecular Phylogenetics

- 8.1. How to construct Phylogenetic trees?
- 8.2. Immunological techniques, Restriction Enzyme sites
- 8.3. Amino acid phylogeny-DNA-DNA hybridizations, Nucleotide sequence comparisons and homologies

Practical :

1. Population genetics : Calculating gene frequencies and genotype frequencies for Autosomal dominant traits, Autosomal recessive traits. Using Binomial distribution
2. Quantitative Genetics : Mean, Standard Deviation, Chi-Square & Variance
3. Problems on related topics
4. Multifactor inheritance

Suggested Reading Material :

1. Dobzhansky, Th. Genetics and origin of Species. Colombia University Press
2. Dobzhansky, Th., F.J. Ayala. G.L. Stebbens and J.M. Valentine. Evolution , Surjeet Publication, Delhi.
3. Futuyama, D.J. Evolutionary Biology. Suinuaer Associates, INS Publishers, Dunderland
4. Hartl, D.L. A Primer of population genetics. Sinauer Associates, INC, Massachusetts
5. Jha, A.P. Genes and Evolution, John Publication, New Delhi
6. King, M. Species Evolution – the role of chromosomal change. The Cambridge University Press, Cambridge.
7. Merrel, D.J. Evolution and genetics. Oxford University Press, New York
8. Strikberger, M.W. Evolution. Jones and Bartett Publishers, Boston, London.

6. GAMETE BIOLOGY

Unit – I :

- 1.0. Heterogamy in eukaryotes
- 2.0. Comparative account of differentiation of gonads in a mammal and an invertebrate
- 3.0. Spermatogenesis
 - 3.1. Morphological basis in Rodents
 - 3.2. Morphological basis in any invertebrates
- 4.0. Biochemistry of semen
 - 4.1. Semen composition and formation
 - 4.2. Assessment of sperm functions

Unit – II :

- 5.0. Ovarian follicular growth and differentiation
 - 5.1. Morphology
 - 5.2. Endocrinology
 - 5.3. Molecular Biology
 - 5.4. Oogenesis and Vitellogenesis
 - 5.5. Ovulation and ovum transport in mammals
- 6.0. Fertilization
 - 6.1. Pre-fertilization
 - 6.2. Biochemistry of fertilization
 - 6.3. Post-fertilization
- 7.0. Collection and cryopreservation of gametes and embryos

Unit – III :

- 8.0. Multiple ovulation and embryo transfer technology (MOETT)
 - 8.1. *In vitro* oocyte maturation
 - 8.2. Superovulation

8.3. *In vitro* fertilization

9.0. Transgenic animals and knock-outs

9.1. Production

9.2. Applications

9.3. Embryonic stem cells

Unit – IV :

10.0. Assisted reproduction technologies

10.1. Embryo sexing and cloning

10.2. Screening for genetic disorders

10.3. ICSI, GIFT etc.

10.4. Cloning of animals by nuclear transfer

11.0. Teratological effects of Xenobiotics

12.0. Immuno contraception

12.1. Gamete specific antigens

12.2. Surgical methods

12.3. Hormonal methods

12.4. Physical methods

12.5. IUCD

Practical :

1. Types of eggs
2. Cleavage, Blastulation, Gastrulation, Frog/Amphioxus/Chick
3. Testis Section Human
Ovary Section Human
4. Mounting spermatozoa – Grasshopper/Frog/Chick/Rat
5. Demonstration class : Pregnancy test using commercial kit

Suggested Reading Material :

1. Austen, C.R. and Short, R.V. Reproduction in animals
2. Schatten and Schatten. Molecular biology of fertilization
3. F.T. Longo. Fertilization, Chapman & Hall
4. R.G. Edwards. Human Reproduction

7. TOOLS AND TECHNIQUES FOR BIOLOGY

Unit – I :

1.0. Assay

- 1.1. Definition
- 1.2. Chemical assay
- 1.3. Biological assay

2.0. Principles and uses of analytical instruments

- 2.1. pH meter
- 2.2. Spectrophotometer
- 2.3. Ultra-centrifuge
- 2.4. Radio activity counter
- 2.5. N.M.R. Spectrophotometer

Unit – II :

3.0. Microscopy

- 3.1. Principles of light, dark field, phase contrast, fluorescence, transmission electron, scanning EM

4.0. Micro-biological Techniques

- 4.1. Media preparation & sterilization
- 4.2. Inoculation & Growth monitoring
- 4.3. Use of fermentors
- 4.4. Biochemical Mutants & their uses
- 4.5. Microbial assays

Unit – III :

5.0. Cell culture techniques

- 5.1. Laboratory facilities
- 5.2. Substrates on which cells grow
- 5.3. Treatment of substrate surfaces
- 5.4. Feeder layers
- 5.5. Culture Media

Unit – IV :

6.0. Separation Techniques in biology

6.1. Molecular separation by chromatography and electrophoresis

6.2. Organelle separation by centrifugation, density gradient separation

7.0. Radio Isotopes

7.1. Sample preparation for radio active counting

7.2. G-M-Counter

7.3. Auto-radiography

Practical :

1. Spectrophotometer – Estimation of biomolecules

2. Centrifugation – Demonstration and working

3. Separation Techniques - Paper chromatography

4. Electrophoresis – Demonstration and usage

5. Demonstration and working of :

a) Atomic Absorption Spectrophotometer

b) High Pressure Liquid Chromatography

c) ELISA Reader

d) Liquid Scintillation counter

6. PH Meter – Preparation of Phosphate buffer

7. Microscope –

a) Demonstration of oil immersion – WBC & RBC

b) Preparation of tissue for SEM & TEM procedure

8. Cell culture -

a) Preparation of media

b) Inoculation

Suggested Reading Material :

1. Animal cell culture – A practical approach, Ed. John R.W. Masters, IRI Press

2. Introduction to Instrumental Analysis. Robert Braun. McGraw Hill International Editions

3. A Biologist Guide to Principles and Techniques of Practical Biochemistry. K. Wilson & K.H. Goulding, ELBS Edn.

8. GENERAL AND COMPARATIVE ENDOCRINOLOGY

Unit – I :

- 1.0 Aims and scope of endocrinology
 - 1.1. Hormones as messengers
 - 1.2. Hormones and eukaryotic metabolic regulation
 - 1.3. Classification of hormones
 - 1.4. Discovery of hormones
 - 1.5. Experimental methods of hormone research
- 2.0. Phylogeny of endocrine glands (Pituitary, pancreas, adrenals, thyroid)
- 3.0. Ontogeny of endocrine glands

Unit – II :

- 4.0. Concept of Neurosecretion and Neuro-endocrine system in invertebrate groups
 - 4.1. Neuro-endocrine mechanisms of moulting and growth in crustaceans
 - 4.2. Hormonal control of reproduction and moulting in insects
 - 4.3. Hormonal control of reproduction in Mollusca and Echinodermata

Unit – III :

- 5.0. General principles of hormone action
 - 5.1. Concept of hormone receptors
 - 5.2. Nature of hormone action, Steroid and protein hormones
 - 5.3. 1st messenger, 2nd messenger concept
 - 5.4. Hormonal control of homeostasis
 - 5.5. Hormonal regulation of carbohydrate metabolism
 - 5.6. Hormonal regulation of nitrogen and lipid metabolism

Unit – IV :

- 6.0. Hormone structure and Biosynthesis of hormones

- 6.1. Chemical nature and gross features of hormones
- 6.2. Hormone levels in circulation and other body fluids
- 6.3. Biosynthesis of steroid hormones *de novo*

- 6.4. Biosynthesis and amino acid derives small size hormones (eg: T4 Epinephrine, etc.)

- 6.5. Biosynthesis and simple peptide hormones, Pre- and Pro-hormones

- 6.6. Co-translational and post-translational modifications of hormone structure

Hormones and behaviour

Hormonal control of growth and reproduction in vertebrates

Neuro-endocrine integration in vertebrate

Practical :

1. Cockroach – *Carpora cardiaca* & *Carpora allata*
2. Prawn – Nervous system, Y-organ and androgenic organ, ovaries
3. Crab – Nervous system, Y-organ & androgenic organ, ovaries
4. Sepia – Optic glands

5. Fish – Endocrine glands: Pituitary, Pancreas, adrenals, testis and ovaries

Suggested Books :

1. E.J.W. Barrington, General and Comparative Endocrinology, Oxford, Clarendon Press.

2. P.J. Bentley, Comparative Vertebrate Endocrinology, Cambridge University Press.

3. R.H. Williams, Textbook of Endocrinology, W.B. Saunders

4. C.R. Martin, Endocrine Physiology, Oxford University Press

5. A Gorbman et. al. Comparative endocrinology, John Wiley & Sons.

III SEMESTER : STREAM – 'A'

1. STRUCTURE AND FUNCTION IN INVERTEBRATES

Unit – I :

1.0. Origin of coelom

- 1.1. Acoelomates, Pseudocoelomates
- 1.2. Coelomates : Protostomia and Deuterostomia

2.0. Locomotion

- 2.1. Flagella and ciliary movement in Protozoa
- 2.2. Hydrostatic movement in Coelenterata, Annelida and Echinodermata

Unit – II :

3.0. Nutrition and Digestion

- 3.1. Patterns of feeding and digestion in lower metazoa
- 3.2. Filter feeding in Polychaeta, Mollusca and Echinodermata

4.0. Respiration

- 4.1. Organs of respiration: Gills, lungs and trachea
- 4.2. Respiratory pigments
- 4.3. Mechanism of respiration

Unit – III :

5.0. Excretion

- 5.1. Organs of excretion: Coelom, Coelomoducts, Nephridia and Malpighian tubules
- 5.2. Mechanisms of excretion
- 5.3. Excretion and Osmoregulation

6.0. Nervous system

6.1. Primitive nervous system: Coelenterata and Echinodermata

6.2. Advanced nervous system : Annelida, Arthropods (Crustacea and insecta) and Mollusca (Cephalopoda)

6.3. Trends in neural evolution

Unit – IV :

7.0. Invertebrate larvae

7.1. Larval forms of free living invertebrates

7.2. Larval forms of parasites

7.3. Strategies and Evolutionary significance of larval forms

8.0. Minor phyla

8.1. Concept of significance

8.2. Organization and general characters

Practical :

1. Nervous system : Crab, Sepia / Loligo
2. Mounting : Nephridium and Spermatotheca in Earthworm
3. Respiratory system : Mounting of Gills, Trachea and Booklungs
4. Protozoa : Gregarines, Monocystis, Ceratium, Euplotes, Didinium, Noctiluca, Adiolarin, Stentor, Opalina
5. Porifera : Sectonal view of *Sycon* (T.S., L.S.) Grantia (T.S.)
6. Cnidaria : Slides of *Obelia* polyp and medusa, *Pennaria*, *Aurelia* – Tentaculocysts
7. Museum specimens of *Virgularia*, *Spongodus*, *Zoanthus*, *Favia*
8. Helminthes – Slides of *Temnocephala*
9. Museum specimens of *Ascaris lumbricoides*. *Taenia solium*, *Planaria*
10. Annelida : Slides of *Ozobranchus*, *Glossiphonia*
11. Museum specimens of *Eunice*, *Chloiea flava*, *Polynoe*, *Terrebella*, *Eurythoe*. *Chaetopterus*
12. Arthropoda – Slides of *Balanus*, *Lepas*. *Palinurus*, *Uca*, *Pyena*, *Hippa*, *Gongylus*. *Belostoma*, *Limulus*, *Squilla*, *Eupagurus*
13. Mollusca – Museum specimens of *Dolabella*, *Pteria*, *Nerita*, *Sanguinolaria*

14. Lambis, Tridacna, Onchidium, Oliva, Murex, Turritella, Bullia, Cardium, Arca
15. Echinodermata – Museum specimens of Echinodiscus, Holothuria and Antedon
16. Museum specimens of minor phyla Phoronis, Dendrostoma
17. Fossil specimens – Aurelia – Planula, Redia, Cercaria, Filiform of stronglyloides, Trochophore, Nauplius, Zoea, Mysis, Phyllosoma, Trilobite larvae of Limulus, Antion, Velliger, Bipinaria, Ophio and Echinopluteus, Auricularia, Tornaria

Suggested Reading Material :

1. Hyman, L.H. The invertebrates. Vol. Protozoa through tenophora, McGraw Hill Co., New York.
2. Barrington, E.J.W. Invertebrate structure and function. Thomas Nelson and Sons Ltd., London.
3. Jagerstein, G. Evolution of metazoan life cycle, Academic Press, New York.
4. Hyman, I.H. The invertebrates. Vol.2, McGraw Hill Co., New York
5. Hyman, I.H. The invertebrates. Vol.8 McGraw Hill Co., New York
6. Barnes, R.D. Invertebrate Zoology. III Edition. W.B. Saunders Co., Philadelphia
7. Russel-Hunter, W.D.A. Biology of higher invertebrates. The Macmillan Co. Ltd., London.
8. Hyman, I.H. The invertebrates smaller coelomate groups. Vol.V. McGraw Hill Co., New York.
9. Read, C.P. Animal Parasitism. Prentice Hall Inc., New Jersey.
10. Sedgwick, A.A. Student textbook of Zoology. Vol.II and III. Central Book Depot. Allahabad.
11. Parker, T.J., Haswell, W.A. Textbook of Zoology, Macmillan Co., London.

2. COMPARATIVE ANATOMY OF VERTEBRATES

Unit – I :

- 1.0. Origin of Chordata
 - 1.1. Concepts of Protochordata
- 2.0. The nature of Vertebrate morphology
 - 2.1. Definition, scope and relation to other disciplines
 - 2.2. Importance of the study of vertebrate morphology
- 3.0. Origin and classification of vertebrates
- 4.0. Common Indian vertebrates : Fishes, amphibians, reptiles, birds & mammals

Unit – II :

- 5.0. Vertebrate integument and its derivatives
 - 5.1. Development, general structure and function of skin and its derivatives
- 5.2. Glands, scales, horns, claws, nails, hoofs, feathers and hairs
- 6.0. General plan of circulation in various groups
 - 6.1. Blood
 - 6.2. Evolution of heart
 - 6.3. Evolution of aortic arches and portal systems

Unit – III :

- 7.0. Respiratory system
 - 7.1. Characters of respiratory tissue
 - 7.2. Internal and external respiration
 - 7.3. Comparative account of respiratory organs
- 8.0. Evolution of urinogenital system in vertebrate series

Unit – IV :

9.0. Sense organs

- 9.1. Simple receptors
- 9.2. Organs of Olfaction and taste
- 9.3. Lateral line system
- 9.4. Electroreception

10.0. Nervous system

10.1. Comparative anatomy of the brain in relation to its functions

10.2. Nerves-cranial, peripheral and autonomous nervous systems

Practical :

1. Dissections : *Trichiurus/Scoliodon* – Digestion, Reproductive, Arterial, venous systems, Neck nerves

2. Museum specimens and slides :

Protochordates – Salpa-sexual, Salpa-asexual, Botryllus, Herdmania

Fishes – *Rhinobatus, Chimera, Acipenser, Amia, Periopthalmus, Triacanthus, Notopterus notopterus, Scatophagus argus, Trichiurus, Mastacembalus armatus, Exocoetus (flying fish), Diodon hystrix, Echenes naucrates*

Amphibians – *Ichthyophis, Geganophis, Rhachophorus, Rana tigrina, Amblystoma*

Reptiles – *Sitana, Chameleon, Phyrnosoma, Chelone mydas*

Birds – Indian Oriole, Indian koel (male), Indian koel (female), Indian tailor bird, kite, jungle fowl.

Mammals – Indian otter, Marmoset, Loris Bat (*Megaderma lyra*), Pangolin Skull and lower jaw of *Chelonia*, Crocodile, Bird, Carnivore mammal (dog), Herbivore mammal (horse)

Types of vertebrae of Procoelus, Opisthocoelus, Amphicoelus, Amphiplatins, Heterocoelus, Axis and atlas vertebrae.

Suggested Reading Material :

1. Alexander, R.M. The Chordata. Cambridge University Press, London.
2. Barrington, E.J.W. The biology of Hemichordata and protochordata. Oliver and Boyd, Edinburgh.
3. Bourne, G.H. The structure and functions of nervous tissue. Academic Press, New York.
4. Carter, G.S. Structure and habit in vertebrate evolution. Sedwick and Jackson, London.
5. Eccles, J.C. The understanding of the brain. McGraw Hill Co., New York and London.
6. Kingsley, J.S. Outlines of comparative anatomy of vertebrates. Central Book Depot, Allahabad.
7. Kent, C.G. Comparative anatomy of vertebrates.
8. Malcom Jollie. Chordata morphology. East-West Press Pvt. Ltd., London
9. Milton Hilderbrand. Analysis of vertebrate structure. IV Ed. John Wiley and Sons Inc., New York.
10. Monieli A.R. The chordates. Ambridge University Press, London.
11. Smith, H.S. Evolution of chordate structure. Hold Rinehart and Winstoin Inc., New York.
12. Sedwick, A.A. Students textbook of Zoology, Vol.II.
13. Tansley, K. Vision in vertebrate. Chapman and Hall Ltd., London.
14. Torrey, T.W. Morphogenesis of vertebrates. John Wiley and Sons Inc., New York.
15. Walters, H.E. and Syles, L.D. Biology of vertebrates. Macmillan & Co., New York.
16. Wolstenholmf, E.W. and Knight, J. (Ed.). Taste and smell in vertebrates. J & A Churchill, London.

17. Romer, A.S. Vertebrate Body, III Ed. W.B. Saunders Co., Philadelphia
18. Young, J.Z. Life of vertebrates. The Oxford University Press, London
19. Young, J.Z., Life of mammals, The Oxford University Press, London
20. Colbert, E.H., Evolution of the vertebrates. John Wiley and Sons Inc., New York.
21. Romer, A.S. Vertebrate Paleontology. 3rd Edn. University of Chicago Press, Chicago
22. Clark, W.E. History of the Primates, IV Edn. University of Chicago Press, Chicago.
23. Weichert, C.K. and Presch, W. Elements of Chordate anatomy. 4th Edn. McGraw Hill Book Co., New York.
24. Messers, H.M. An introduction of vertebrates anatomy
25. Montagna, W. Comparative anatomy. John Wiley and Sons Inc.
26. De Deer, S.G. Embryos and Acestor. Clarendon Press, Oxford
27. Andrews, S.M. Problems in vertebrate evolution. Academic Press, New York.
28. Waterman, A.J. Chordata structure and function. Macmillan Co., New York.
29. Joysey, K.A. and T.S. Kemp. Vertebrate evolution. Oliver & Boyd, Edinborough.
30. Lovtrup, S. The phylogeny of vertebrate. John Wiley & Sons, London.
31. Barbiur, T. Reptiles and Amphibians: Their habits and adaptations. Hongton Miffin Co., New York.
32. Kingsley Noble, G. The biology of the Amphibia. Dover Publications, New York.

33. Smyth. Amphibia and their ways. The Macmillan Co., New York.
34. Andrevos, S.M. Miles, R.S. and Walker A.D. Problems in vertebrate evolution. Academic Press, New York.

3. POPULATION ECOLOGY

Unit – I :

Origin of groups – Reproduction- passive transport - Active Locomotion - Common orientation - Mutual Attraction

Population Regulation – Effects of increased numbers – Harmful Effects – Beneficial Effects – Protection – Influence on reproduction – Division of labour

Unit – II :

Population growth – Natality and Mortality Biotic Potential and Environmental resistance – Form of population growth – Logistic Curve – Stochastic and time lag models of population growth – Optimal yield

Population – Inter-specific relationships – Positive interactions – Commensalism – Mutualism – Negative interactions – Predation – Parasitism – Antibiosis

Unit – III :

Community concept – Community dominance – Ecotone – Community composition – Stratification of community

Habitat and Ecological Niche – Ecological Equivalent – Sympatry and Allopatry – Spatial relations of populations – Space requirements – Home range and Territory – Homing and return migration – Emigration

Unit – IV :

Demography – Life Tables – Net Reproductive rate – Longevity and theories of ageing – Reproductive strategies

Fish population – Population density – Population structure : Year classes – Estimation of population – Population dynamics – Abundance in population and fishery – Population dynamics and fishery catches.

Practical :

1. Enumeration of Zooplankton
2. Enumeration of phytal fauna

3. Enumeration of Rocky shore fauna
4. Enumeration of macrobenthos
5. Enumeration of meiobenthos
6. Creation of Life Table
7. Calculation of net reproductive rate (R_0), Generation time (T), Rate of intrinsic growth and optimal age for sexual maturity
8. Calculation of logistic and exponential growth of a given population
9. Zooplankton – Identification (10 examples)
10. Identification of Rocky shore fauna (10 examples)

Suggested Reading Material :

1. Begon, M., J.L. Harper and C.R. Townsend. Ecology, Individuals, Populations and Communities. Blackwell Science, Oxford, UK.
2. Koromondy, E.J. Concepts of ecology. Prentice Hall, New Delhi.
3. Clarke, G.L. Elements of Ecology, John Wiley & Sons, New York.
4. Odum, E.P. Fundamentals of Ecology. W.B. Saunders, Philadelphia.
5. Krebs, C.J. Ecology. Harper & Row, New York.
6. Jorgensen, S.E. Fundamentals of Ecological modeling. Elsevier, New York.

4. ANIMAL BEHAVIOUR

Unit – I :

1.0. Introduction

- 1.1. Ethology as a branch of biology
- 1.2. Animal psychology – classification of behavioural patterns, analysis of behaviour (ethogram)

2.0. Biological rhythms

- 2.1. Circadian and circannual rhythms
- 2.2. Orientation and navigation
- 2.3. Migrations of fish, turtle and birds

3.0. Neural and Hormonal control of behaviour

Unit – II :

4.0. Innate behaviour

5.0. Perception of the environment

- 5.1. Mechanical
- 5.2. Electrical
- 5.3. Chemical
- 5.4. Olfactory
- 5.5. Auditory
- 5.6. Visual

Unit – III :

6.0. Ecological aspects of behaviour

- 6.1. Habitat selection, food selection, Optimal foraging, theory, antipredator defenses
- 6.2. Aggression, homing, territoriality, dispersal
- 6.3. Host – parasite relations

7.0. Social behaviour

7.1. Aggressions – Schooling in fishes, flocking in birds, herding in mammals

7.2. Group selection, kin selection, altruism, reciprocal altruism, inclusive fitness

7.3. Social organization in insects and primates

Unit – IV :

8.0. Reproductive behaviour

8.1. Evolution of sex and reproductive strategies

8.2. Mating systems

8.3. Courtship

8.4. Sperm competition

8.5. Sexual selection

8.6. Parental care

9.0. Communication

9.1. Chemical

9.2. Visual

9.3. Light

9.4. Audio

Practical :

1. An introduction to animal behaviour – Animal Psychology – Classification of behavioural patterns
2. Perception of the environment – Examples
3. communication – Examples from invertebrates and vertebrates (Terrestrial, Aerial, Aquatic habitats)
4. Ecological aspects – Food selection, optimal foraging, prey and predator, Host-Parasite relations
5. Social behaviour – Aggregations – Examples from fishes, birds and mammals, social organization - insects

6. Reproductive behaviour – mating systems, sexual selection, parental care
7. Biological rhythms – examples – migration of fish, turtle and bird.

Suggested Reading Material :

1. Alcock, J. Animal behaviour : An evolutionary approach. Sinauer Assoc., Sunderland, Mass, USA
2. Bradbury, J.W. and S.I. Vehrencamp, Principles of animal communication. Sinauer Assoc.
3. Clutton-Brock, T.H. The evolution of parental care. Princeton Univ. Press, Princeton, N.J., USA.
4. Eibl-Eibesfeldt, I. Ethology. The biology of behaviour. Holt, Rinehart & Winston, New York.
5. Gould, J.L. The mechanisms and evolution of behaviour.
6. Hauser, M. The evolution of communication. MIT Press, Cambridge, Mass, USA.
7. Hinde, R.A. Animal behaviour : A synthesis of ethology and comparative psychology. McGraw Hill, New York.
8. Krebs, J.R. and N.B. Davies. Behavioural ecology. Blackwell, Oxford, UK.
9. Wilson, E.O. Sociobiology. The new synthesis. Harvard Univ. Press, Cambridge, Mass, USA.

STREAM - 'B'

1. BIOLOGY OF VERTEBRATE IMMUNE SYSTEM

Unit – I :

- 1.0. Innate and acquired immunity
- 2.0. Phylogeny and ontogeny of immune system
 - 2.1. Organization and structure of lymphoid organs
 - 2.2. Cells of the immune system and their differentiation
 - 2.3. Lymphocyte traffic
- 3.0. Nature of immune response

Unit – II :

- 4.0. Nature of antigens and superantigens
 - 4.1. Antigenicity and immunogenicity
 - 4.2. Epitopes and haptens
- 5.0. Structure and functions of antibodies
 - 5.1. Classes and sub-classes
 - 5.2. Gross and fine structure
 - 5.3. Antibody mediated effector functions
 - 5.4. Antigen-Ab interactions
- 6.0. Major Histocompatibility in mouse and HLA system in human
 - 6.1. MHC haplotypes
 - 6.2. Class I and Class II molecules
 - 6.3. Peptide binding
 - 6.4. Disease susceptibility and MHC / HLA

Unit – III :

- 7.0. Organization and expression of Ig genes
 - 7.1. Models for Ig gene structure

- 7.2. Multigene organization and mechanisms
- 7.3. Generation of antibody diversity

- 8.0. T-cell receptors
 - 8.1. Isolation, molecular components and structure
 - 8.1. T-cell maturation and thymus
 - 8.3. TH – cell activation mechanism
 - 8.4. T-cell differentiation
 - 8.5. Cell death and T-cell population

Unit – IV :

- 9.0. B-cell receptors
 - 9.1. Selection of immature self-reactive B-cells
 - 9.2. B-cell activation and proliferation
 - 9.3. TH B cell interactions
 - 9.4. Humoral immune response - kinetics

- 10.0. Cell-mediated effector functions
 - 10.1. Effector cells and molecules
 - 10.2. CTL and NK cells – mechanisms of action
 - 10.3. Delayed type hypersensitivity

Practical :

Organs :

1. Lymphoid organs in Rat - Dissection
2. Lymphoid organs – Histology slides
3. Cells – Differential count of blood cells – Staining with Giemsa
4. Lymphocyte separation – Gradient methods
5. Antigen – Antibody reactions – Kits
 - a) Determination of blood groups
 - b) Diagnostic test for typhoid
 - c) Quantitative precipitin assay teaching kit
 - d) Test for HBS Ag.

e) Estimation of serum proteins

Suggested Reading Materials :

1. Kuby, W.H., Freeman, Immunology, USA
2. W. Paul, Fundamentals of immunology
3. I.M. Roitt, Essential immunology, ELBS ion.

2. GENES AND DIFFERENTIATION

Unit – I :

1.0. Introduction to animal development

- 1.1. Developmental patterns in metazoans
- 1.2. Development in unicellular Eukaryotes

Creating multicellularity

- 2.1. Cleavage types
- 2.2. Comparative account of Gastrulation

3.0. Early vertebrate development

- 3.1. Neurulation and ectoderm
- 3.2. Mesoderm and endoderm

Unit – II :

4.0. Cytoplasmic determinants and autonomous cell speciation

- 4.1. Cell commitment and differentiation
- 4.2. Cell specification in nematodes
- 4.3. Germ cell determinants
- 4.4. Progressive cell – cell interaction and cell specification fate

5.0. Body axes

- 5.1. Establishment of body axes in mammals and birds
- 5.2. Genetics of axis specification in drosophila
- 5.3. Homeobox concept

6.0. Tetrapod limb development

Unit – III :

7.0. Hormones as mediators of development

- 7.1. Amphibian metamorphosis
 - 7.2. Insect metamorphosis
 - 7.3. Ovarian luteinization and mammary gland differentiation
- 8.0. Environmental evolution and animal development
- 8.1. Environmental cues and effects
 - 8.2. Malformations and disruptions
 - 8.3. Changing evolution through development modularity
 - 8.4. Developmental constraints
 - 8.5. Creating new cell types – basic evolutionary mystery

Unit – IV :

- 9.0. Cell diversification in early animal embryo
- 9.1. Morphogen gradients
 - 9.2. Totipotency & Pluripotency
 - 9.3. Embryonic stem cells
 - 9.4. Renewal by stem cells - epidermis
 - 9.6. Skeletal muscle regeneration
 - 9.7. Connective tissue cell family
- 10.0. Hemopoietic stem cells
- 10.1. Blood cells formation
 - 10.2. Bone marrow transplants
 - 10.3. Gene therapy

Practical :

1. Types of cleavages : Invertebrates, vertebrates, and permanent preparations – stains of stages of blastula
2. Development of Amphibian – Gastrulation - Metamorphosis
3. Insect metamorphosis – Endocrine identification
4. Sex determination – *Drosophila* (Prescribed assignments with problems in genetics)

5. Stem cells – Staining of bone marrow identification of cells (animal example)

Suggested Reading Material :

1. S.F. Gillert, Developmental biology, Sinauer, Associates Inc., Massachusetts.
2. Ethan Bier. The cold spring. Cold Spring Harbor Lab. Press, New York.

3. MOLECULAR CYTOGENETICS

Unit – I :

1.0. Biology of chromosomes

1.1. Molecular anatomy of eukaryotic chromosomes

1.2. Metaphase chromosomes : Centromere, Kinetochore, Telomeres and its maintenance

1.3. Heterochromatin and euchromatin

1.4. Giant chromosomes : Polytene and lampbrush chromosomes

2.0. Sex chromosomes, Sex determination and dosage compensation in *C. elegans*, *Drosophila* and humans

Unit – II :

3.0. Somatic cell genetics

3.1. Cell fusion and hybrids – agents and mechanism of fusion

3.2. Heterokaryon – selecting hybrids and chromosome segregation

3.3. Radiation hybrids, hybrid panels and gene mapping

4.0. Microbial genetics

4.1. Bacterial transformation, transduction, conjugation, bacterial chromosomes

4.2. Bacteriophages: types, structure and morphology of T4 phage, Morphogenesis

Unit – III :

5.0. Human cytogenetics

5.1. Techniques in human chromosome analysis – molecular cytogenetic approach

5.2. Human karyotype – banding - nomenclature

5.3. Numerical and structural abnormalities of human chromosomes – syndromes – Cytogenetic implications

5.4. Mendelian and chromosome based heritable diseases in Man

6.0. Molecular cytogenetic techniques

6.1. FISH, GISH

6.2. DNA finger printing

6.3. Flow cytometry

6.4. Automated karyotyping

6.5. Chromosome painting

Unit – IV :

7.0. Linkage map, cytogenetic mapping

7.1. Physical maps and molecular maps

7.2. Strategies of different levels of genome mapping

8.0. Genetics of cell cycle

8.1. Genetic regulation of cell division in eukaryotes

8.2. Molecular basis of neoplasia

Practical :

1. Staining of metaphase chromosomes – Chromosomal banding – stain with giemsa – fluorescent dye - demonstration
2. Polytene chromosomes – banding – *Chironomus* / *Drosophila* larva
3. Structural abnormalities in chromosomes (Rhoeo – plant mature)
4. Demonstration/exploration of FISH, GISH, DNA Finger printing
5. Microbial genetics – assignments & problems
6. Human chromosomes - karyotyping

Suggested Reading Material :

1. Atherly A.G., J.R. Girton and J.F. McDonald. The Science of Genetics. Saunders College Publishing. Harcourt Brace College Publishers, NY.
2. Brooker, R.J. Genetics : Analysis and principles. Benjamin / Cummings, Longman Inc.
3. Fairbanks, D.J. and W.R. Anderson. Genetics – The continuity of life. Brooks / Cole Publishing Company, TTP, NY, Toronto.
4. Gardner, E.J., M.J. Simmons and D.P. Snustads. Principles of Genetics, John Wiley and Sons Inc., NY.
5. Griffith, A.J.F., J.H. Miller, D.T. Suziki, R.C. Lewontin and W.M. Gellbart. An introduction to genetic analysis. W.H. Freeman and Company, New York.
6. Lewin, B. Genes. VI Oxford University Press, Oxford, New York, Tokyo.
7. Snustad, D.P. and M.J. Simmons. Principles of Genetics. John Wiley and Sons Inc., NY.

8. Watson, J.D., N.H. Hopkins, J.W. Roberts, J.A. Steitz and A.M. Winer. *Molecular Biology of Genes*. The Benjamin / Cummings Pub. Co. Inc, Tokyo.

4. MOLECULAR BIOLOGY

Unit – I :

History and scope of Molecular Biology

2.0. DNA Structure and Replication

- 2.1. Prokaryotic and Eukaryotic DNA Replication
- 2.2. Mechanics of DNA Replication
- 2.3. Enzymes and accessory proteins involved in DNA Replication

Unit – II :

3.0. Transcription

- 3.1. Prokaryotic Transcription
 - 3.2. Eukaryotic Transcription
 - 3.3. RNA Polymerases
- 4.0. Post-transcriptional modifications in RNA
- 4.1. Cap formation
 - 4.2. Splicing
 - 4.3. Nuclear Export of m-RNA

Unit – III :

5.0. Translation

- 5.1. Genetic Code
 - 5.2. Prokaryotic and eukaryotic Translation
 - 5.3. Mechanisms of initiation, elongation and termination
 - 5.4. Regulation of translation
- 6.0. Antisense and Ribozyme technology
- 6.1. Molecular mechanisms of antisense molecules
 - 6.2. Inhibition of splicing, polyadenylation and translation

Unit – IV :

7.0. Recombination and Repair

- 7.1. Holiday junction, gene targeting and gene disruption
- 7.2. RecA and other Recombinases
- 7.3. DNA repair mechanisms

8.0. Molecular mapping of genome

- 8.1. Genetic and physical maps
- 8.2. Physical mapping and map-based cloning
- 8.3. Southern fluorescence insitu hybridization (FISH) for genome analysis

Practical :

1. Estimation of DNA (Colorimetric method)
2. Estimation of RNA in tissue (Colorimetric method)
3. Fulgen reaction method for DNA localization
4. Localization of RNA by methylgreen pyronin – 'Y'
5. Polymerase chain reaction (Demonstration)
6. RELP Analysis (Demonstration)

Suggested Reading Material :

1. J.D. Watson, N.H. Hopkins, J.W. Roberts, J.A. Steitz and A.M. Weiner. Molecular biology of Gene. The Benjamin/Cummings Pub. Co. Inc., California.
2. Alberts, B., D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson. Molecular Biology of the Cell. Garland Publishing Inc., New York.
3. Benjamin Lewin, Gene IV, Oxford University Press, U.K.
4. Meyers, R.A. (Eds.) Molecular Biology and Biotechnology : A comprehensive desk reference. VCH Publishers Inc., New York.

5. Sambrook, J., E.F. Fritch and T. Maniatis. Molecular cloning : A Laboratory Manual. Cold Spring Harbor Laboratory Press, New York.
6. Daber, P.D. Introduction to practical Molecular Biology. John Wiley & Sons Ltd., New York.
7. Brown, T.a. (Eds.). Molecular Biology LabFax. Bios Scientific Publishers Ltd., Oxford.

IV SEMESTER
(A) STREAM - ELECTIVE

1. COASTAL AND MARINE BIODIVERSITY

Unit – I

1. Coastal and marine Biodiversity. Concepts and approaches. The RIO convention. Agenda 21 – Populations at sea.
2. Life in the Intertidal Zone – rocky, sandy and muddy shore-organisms and adaptations. Shallow water benthic communities – Food chain.

Unit – II :

3. Sea- grass and saltmarsh and mangrove communities
4. Biology of estuaries – Estuarine adaptations

Unit – III :

5. Coral reef communities – the Indian examples – Conservation methods
6. Coastal lagoons – Physico-chemical conditions and biota

Unit – IV :

7. Biology of pollution – Effects on coastal and marine bio-diversity
8. Integrated Coastal Zone Management importance. Exclusive Economic Zone (EEZ) – UN law of sea Ocean policy Indian Role of NGOs coastal communities, case studies.

Practical :

1. Life in the intertidal zone with special reference to Waltair Coast, collection of material and their identification
2. 10 examples of muddy shore forms
3. 10 examples of sandy shore forms
4. Measuring tidal level using the stave method

5. Critical marine habitats of Indian Sub-Continent: Show geographic locations on a map and prepare sketches of important Coral reef species, mangroves and associate fauna and flora.

Suggested Reading Material :

1. Hedgepeth, J.W. Treatise on marine Ecology and Paleoecology. Geological Society of America, New York.
2. Bames, R.S.K. Estuarine Biology. Edwards Arnold, London.
3. Russel, F.S. and Yonge, C.M. , Frederic Warne. The seas.
4. Newell R.C. Biology of intertidal animals. Marie Ecological Surveys Ltd.
5. Nybakken, J.W. Marine Biology : An ecological approach. Harper Collins College Publishers, New York.

2. BIOLOGICAL OCEANOGRAPHY

Unit – I :

1. Classification of the marine environment – Topographical features – Continental shelf, continental slope, submarine canyons, ridges, trenches, basins, guyots of the sea floor with special reference to Indian Ocean and adjacent seas
2. Chemistry of seawater – Major and minor constituents, trace elements, chlorinity and salinity – Dissolved oxygen and Carbon dioxide system.
3. Inorganic nutrients in the sea – Distribution of nitrogen, phosphorous and silicon and factors affecting their distribution

Unit – II :

4. Marine sediments : Constituents, classification, transportation
5. Water masses, formation and classification. T-S diagrams. Water masses of the World's Oceans with particular reference to Indian Ocean and adjacent seas

Unit – III :

6. Mixing processes in the Sea – Currents of the world's Oceans
7. A general account waves and tides in the sea. Spring tide, neap tide, causative agencies. Significance in mixing

Unit – IV :

8. Oceanographic studies in Bay of Bengal with particular reference to east coast of India
9. Oceanographic Instruments : Grab (Petersen, Van Veen, Smith-Mcintyre) for benthos collection, naturalist's dredge (Ekman, Sanders deep-sea anchor dredge), Plankton nets, Continuous plankton recorder, Multiple plankton, Sampling System, reversing Nansen bottles, reversing thermometer, salinometer, bathythermograph, secchi disc. Ekman current meter, echo-

sounders, CTD, underwater photographic equipment, SCUBA apparatus.

Practical :

1. Preparation of charts showing ocean topography with special reference to Indian Ocean and Bay of Bengal.
2. Oceanographic instruments, drawing sketches and familiarization with working.
3. Sediments : Analysis of textural classes and organic carbon
4. Estimation of salinity by Knudsen's method, estimation of inorganic nutrients.
5. Sketches showing Ekman Spiral, Antarctic and sub-tropical convergence phenomena and water masses of the world's oceans. T.S. Diagrams representative features.

Suggested Reading Material :

1. Sverdrup, H.U., M.W. Johnson and R.H. Fleming. The Oceans, their Physics, Chemistry and General Biology. Prentice Hall, Engel Wood Cliffs.
2. Tomezak and J.S. Godfrey. Regional Oceanography : An Introduction.
3. Lalli, C.M. & Parsons, T.R. Biological Oceanography : An Introduction. Pergamon Press
4. Pickard, G.L. Descriptive Physical Oceanography. Pergamon Press.
5. Weisberg, J. and H. Parish. Introductory Oceanography. McGraw Hill, Kogakusha Ltd.
6. Riley, J.P. and R. Chester. Introduction to Marine Chemistry. Academic Press, London and New York.

3. MARINE BIOLOGY

Unit – I :

1. The sea as biological environment – General characters of populations and primary biotic divisions
2. Biological productivity, Primary production : Methods of measuring Primary production, latitudinal variations, factors affecting primary production, productivity in relation to fisheries

Unit – II :

3. Phytoplankton composition, availability, seasonal variations and factors affecting distribution and abundance
4. Zooplankton, composition distribution. Factors affecting abundance. Zoo-phytoplankton relationships, diurnal vertical migrations. Indicator species among Zooplankton. Measuring secondary production

Unit – III :

5. Oceanic Nekton – Composition and ecological adaptations
6. Benthos, methods of collection and analysis. Shallow water marine benthic communities. meiobenthos

Unit – IV :

7. Deep-sea environment – Life and environmental conditions
8. Marine Bio-deterioration – Fouling and boring organisms
9. Marine bioactive compounds.

Practical :

1. Enumeration and Identification of phytoplankton, representative species numbering 25-30. Drawing sketches.

2. Zooplankton species – composition and identification of 30-35 forms. Sorting individuals of mero and holoplankton. Drawing sketches.
3. Marine benthos – collection procedure and group-wise sorting. Important examples of sub-littoral fauna off Visakhapatnam
4. Marine foulers and borers – Taxonomic features with examples
5. Primary productivity estimation : Light and dark bottle technique and demonstration of labeled carbon method.

Suggested Reading Material :

1. Nybakken, J.W. Marine Biology : An ecological approach. Harper Collins College Publishers, New York.
2. Fincham, A.A. Basic Marine Biology. Cambridge University Press.
3. Sverdrup, HU, M.W. Johnson and R.H. Fleming. The Oceans, their physics, chemistry and general biology. Prentice Hall, Englewood Cliffs.
4. Boaden, J.S. and R. Seed. An Introduction to coastal ecology. Chapman and Hall, New York.
5. Raymont, J.E.G. Plankton and Productivity in the Oceans. A Pergamon Press, New York.
6. Wickstead, J.H. An introduction to the study of tropical plankton. Hutchinson.

4. LIMNOLOGY

Unit – I :

1.0. Freshwater habitats :

Introduction – Basic concepts and scope of Limnology. Its future

Types of freshwater habitats. Origin and classification of lakes, natural and Man-made lakes, reservoirs

Anomalous properties of water

Unit – II :

Solar Radiation :

Light as a factor – Factors affecting the availability of Light in lakes. Euphotic zone, Light penetration. Extinction coefficient, transparency of waters and its measurement

3.0. Temperature

3.1. Temperature as a factor – Thermal radiation, Fate of Heat in natural waters, Thermal stratification, Heat Budget

Unit – III :

4.0. Chemical characters of water as a medium of life

4.1. Dissolved Oxygen – Its content in stratified and unstratified lake waters. Seasonal distribution of oxygen in tropical, temperate and sub-polar lakes, Oxygen and aquatic animals

4.2. Carbon Dioxide in lake waters – Hydrogen ion concentration, Buffering effect of CO₂ system, Redox potential, Alkalinity and Total Hardness.

4.3. Nutrients – Availability, Seasonal distribution and regeneration of phosphorous, Nitrogen, Silica

5.0. Freshwater Ecology

- 5.1. Freshwater environment, Ecological classification of freshwater organisms

Unit – IV :

6.0. Productivity

- 6.1. Classification of water bodies based on productivity
- 6.2. Trophic levels and energy turnover, food chains and productivity (primary, secondary productivities and methods for estimation)
- 6.3. Environmental resistance and biotic potential, eutrophication and its control

7.0. Freshwater biota :

- 7.1. Classification and distribution of freshwater biota, adaptations to the lacustrine and methods for estimation
- 7.2. Plankton – Distribution, seasonal variation in space and time, planktonic migration, Cyclomorphosis.

Practical :

1. Analysis of water samples for various physico-chemical parameters – Hydrogen ion concentration, free CO₂ dissolved oxygen, alkalinity, chloride, hardness, nitrates, phosphates, BOD, COD
2. Estimation of primary productivity by light and dark method.
3. Composition and biomass of phytoplankton
4. Collection, enumeration and biomass of Zooplankton
5. Collection and identification of freshwater benthic organisms
6. Visit to freshwater bodies in and around Visakhapatnam.

Suggested Reading Material :

1. Welch, P.S. Limnology. McGraw Hill Book Company, New York.
2. Ruttner, F. Fundamentals of Limnology. University of Toronto Press, 1968.
3. Welch, P.S. Limnological Methods. McGraw Hill Book Company, New York.
4. Gerald, A. Textbook of Limnology. The C.V. Morby Co., 1970.
5. Hutchinson, G.E.A. Treatise on Limnology. Vol.1. John Wiley & Sons, 1957.

5. ICHTHYOLOGY

Unit I

1. Systematics and nomenclature : Suitability of fishes : Historical background tasks of the systematics : Taxonomic concepts. Data of classification: Zoological nomenclature.
2. Major groups of fishes : Scope of classification, aims of classification, methods of classification : Major groups of living fishes, major groups of extinct fishes : Phylogeny of fishes.

Unit II

3. Basic fish anatomy : Digestive system, circulatory system, respiratory system – structure of gills, excretory system – structure of kidney,
4. Structure and function of Nervous system, sense organs and lateral system. Structure of the Reproductive organs.

Unit III

5. Food and feeding habits : Food – Kinds and varieties, abundance of food and its availability, structural adaptation, search for food, classification based on food and feeding habits.
6. Body form and locomotion : Body form and locomotion, fins and locomotion. Age and growth: Growth, length frequency data. Variation in growth rate, age determination.

Unit IV

7. Genetics and Evolution : Inheritance in fishes, sex determination, hybridization, mechanism of evolution
8. Ecology of fishes : Introduction: Water – Organic production in aquatic ecosystems: bio-geo chemical cycles: Ecological classification of fishes, ecological factors.

Practical :

1. Identification of fishes with suitable examples from each class.
2. Dissection of fish for internal anatomy – External characters, types of scales, fins, types of teeth, structure of alimentary canal, gill rakers.
3. Ecology of fishes – Identification characters of pelagic, mid pelagic, benthic and migratory fishes

Suggested Reading Material :

1. Lagler, K.F. Ichthyology. John Wiley Publication, 1977.
2. Norman, J.R. & P.H. Green Wood. A history of fishes.
3. Bond, E. Carl. Biology of fishes.
4. Nikolsky, G.V. Ecology of fishes. Academic Press.
5. Love, M.S. & Cailiet, G.M. Readings in Ichthyology. Prentice Hall Publications, 1979.

6. CAPTURE FISHERIES

Unit – I :

1.0. Fish catch statistics of the world

A general survey of inland and marine fish catches of India and the world (Available Fishing Potential, Estimation of Inland fish, Estimation of marine fish landings and Fisheries of different Marine States.

2.0. Craft and Gear used in Inland and Marine Fisheries :

Traditional and mechanized boats and nets used in catching fish

Unit – II :

3.0. Freshwater Fisheries :

Riverine Fisheries : River systems in India, their ecology and fisheries (Ganga, Brahmaputra, East Coast River system and West Coast river system)

Reservoir Fisheries : Development, Exploitation and management of Reservoirs with special reference to India – Dams and their effect on fish migration

4.0. Estuarine Fisheries :

Major Estuaries of India and their fisheries (Hooghly – Matlah, Mahanadi, Godavari, Krishna, Cauvery and West Coast estuaries)

Brackishwater Fisheries : Chilka lake, Pulicat lake and Kerala back waters

4.3. Hilsa fishery – causes of decline and efforts for revival

Unit – III :

5.0. Fisheries of Indian Seas :

5.1. Marine fish catch in India and fisheries of commercial importance

Fin Fish : 1) Oil Sardines; (2) Mackerels; (3) Tuna and allied fishes; (4) Seer fish; (5) Flat Fish

5.2. Shell fish : 1) Crustaceans; (2) Molluscs; (3) Sea weeds; (4) Edible Oysters

5.3. Sea weeded fishery

6.0. Population Dynamics

6.1. Fish populations and factors affecting the population structures

6.2. Estimation of fish yield and control of over-fishing

Unit – IV :

7.0. Preservation and processing

7.1. Methods of preservation of both finfish and shell fish and associated problems

7.2. Rigor mortis and post-mortem changes

7.3. Fish products and By-products

8.0. Fishery Management

8.1. Yield and optimum catch

8.2. EEZ and its strategy

8.3. Fish transport and marketing including fishery co-operatives

8.4. Fishery education, training and extension

Practical :

1. Identification of Freshwater, Brackish water and Marine Fish

2. Observing different boats, nets and other instruments used in fishery

3. Biological Analysis of fish samples for gut contents, maturity stages and fecundity

4. Fieldwork : Visit to fish landing and processing centres

Suggested Reading Material :

1. Jhingran, V.G. 1993. Fish and fisheries of India. Hindustan Publishing Corporation (India), New Delhi.
2. Ricker, W.E. 1984. Methods for assessment of fish production in freshwaters. Blackwell Publications.
3. Srivastava, C.B.L. 1985. Textbook of Fishery Science and Indian Fisheries. Kutub Mahal Publications, Allahabad.
4. Bal, D.V. and Veerabhadra Rao, K. 1984. Marine Fisheries. IBH Publications
5. Kurian, C.V. and Sebastian, V.O. 1986. Prawns and prawn Fishery of India. Hindustan Publishing Corporation (India), New Delhi.

7. AQUACULTURE

Unit – I :

- 1.0. History, General principles and economics of different kinds of aquaculture and productivity of culture ponds
- 2.0. Freshwater Aquaculture :
 - 2.1. Construction of fish farm and reclamation of swamps
 - 2.2. Selection of species for culture – Biological principles
 - 2.3. Preparation and management of nursery ponds, rearing ponds and stocking ponds along with control of weeds, pests and predators

Unit – II :

- 3.0. Fish seed resources :
 - 3.1. Procurement and transportation of seed from natural resources
 - 3.2. Transportation of brood stock and induced breeding
 - 3.3. Construction of hatcheries and their management
- 4.0. Freshwater fish culture :
 - 4.1. Common carp; Indian Major carps; Air breathing fishes; Composite Fish Culture; Freshwater prawn culture
 - 4.2. Integrated Fish Farming – Paddy cum Fish Culture and Fish cum Livestock Culture

Unit – III :

- 5.0. Fish nutrition

Nutritional requirements, energy metabolism, formulation and preparation of fish feeds
- 6.0. Brackish water aquaculture :

- 6.1. Selection of site, principles of pond design; traditional, extensive, modified extensive, semi-intensive, intensive and super intensive culture of shrimps and their management and economics
- 6.2. Crab culture – Pond design, management of crab farm, fattening process of crab, economics – cage culture and pen culture
- 6.3. Finfish culture – Mulletts (Mugil), Milk fish (Chanos) and sea bass (Lates)

Unit – IV :

7.0. Hatchery management :

- 7.1. Principles of shrimp hatchery establishment : Site selection, water source, water management, maturation section, larval and post larval sections, feed management
- 7.2. Principles of establishment of crab and lobster hatcheries; site selection, water source and management, larval and post larval sections, feed management

8.0. Brackish water farm management :

- 8.1. Water quality management – pH, turbidity, dissolved oxygen, BOD, COD, Nitrates, Phosphates, Ammonia etc.
- 8.2. Feed management : Feed schedules, protein requirements at different ages of finfish and shellfish, feed formulations, wet and dry feeds

9.0. Mariculture :

- 9.1. Lobster culture
- 9.2. Mussel culture
- 9.3. Pearl oyster culture
- 9.4. Edible oyster culture, and
- 9.5. Sea weed culture

Practical :

1. Analysis of water : Turbidity, pH, Dissolved oxygen, Alkalinity etc.
2. Primary productivity, Estimation by Light and Dark bottle method
3. Spotters : cultivable species of finfish and shellfish based on the theory
4. Dissecting out the pituitary gland and preparing the extract
5. Visits to aquaculture farms, finfish and shellfish hatcheries

Suggested Reading Material :

1. Pillay, T.V.R. 1990. Aquaculture – Principles and Practices. Fishing News Books Survey, U.K.
2. Jhingran, V.G. 1993. Fish and fisheries of India. Hindustan Publishing Corporation (India), New Delhi.
3. Ravishankar Piska, 1999. Fisheries and Aquaculture. Lahari Publications, Hyderabad.
4. Santanam, R., Ramanathan, N. and Jegatheesan, G. 1990. Coastal Aquaculture in India. CBS Publishers & Distributors, Delhi.
5. Bardach, J.E., Ryther, J.H. and McLarney, W.O. 1972. Aquaculture. John Wiley & Sons Inc., USA.
6. Ghosh, S., Palanisamy, K. and Pathak, S.C. 1994. Shrimp and Freshwater Hatchery Public Relations Division, National Bank for Agriculture and Rural Development, Bombay.

8. WILDLIFE & CONSERVATION BIOLOGY

Unit – I :

1. Wildlife Introduction – Significance – Depletion – Wildlife values – Major threats – Conservation methods – Special conservation programmes
2. Wildlife management : Legislative, administrative and ecological approaches in India, Forest Acts, Wildlife Act, other relevant acts, schedules, latest amendments, different organizations and supporting agencies. National and International Agencies and conventions concerned with wildlife and conservation.

Unit – II :

3. Endangered species : Their status in various states of India – Endangered species of South India (Marine turtles, crocodiles & other reptiles, birds, whales, dolphins, Dugongs and other mammals and their management). IUCN criteria for allocation into different Red List classes.
4. Concept and significance of conservation of Flagship (Target) species – Wildlife projects sponsored in India

Unit – III :

5. Wildlife Sanctuaries and national parks in Andhra Pradesh : Bird, Sanctuaries, national parks, projects and associated flora and fauna, protected areas and zoos.
6. Biodiversity : Concept, approach and significance – Conservation methods and trials for sustainable development – Natural resource management and conservation – Importance and performance of joint forest management (JFM) – Role of Non-Government Organizations (NGO).

Unit – IV :

7. Wetland ecosystems : Freshwater Bodies – Impact and significance of Human Intervention on Biodiversity, Threatened flora and fauna and conservation methods (Kondakarla Lake as a

case study) – Modern methods of documentation of wildlife (still and video photography)

8. Zoogeography : Geographical distribution of animals – Oriental, Palaearctic, Nearctic, Neotropical, Ethiopian and Australian Regions.

Practical :

1. Identification of threatened and endangered wild fauna of different (Terrestrial, freshwater, estuarine and marine) habitats.
2. Identification of mangrove associated wild fauna
3. Field visits to nature spots : breeding sites, nesting sites and observations at water holes
4. Visiting Kondakarla lake, Coringa mangroves and Tyda Eco-tourism Centre
5. Visits to insight conservation areas
6. Biodiversity indices : Similarity indices, indices for species diversity

OR

Field works : Visit to Insitu conservation areas

7. Identification of representative examples of mangroves

Suggested Reading Material :

1. Owen, D.S. 1985. Natural Resources Conservation – An ecological approach. McMillan Publications & Co., New York.
2. Gee, E.P., 1964. The wild life of India. Collins, London.
3. Ellerman, J.R. 1961. The fauna of India. Manager of Publications, New Delhi.
4. Sanderson, Ivan T. 1955. Living mammals of the world. Hamilton, London.

5. Pocock, R.I. 1941. The fauna of British India including Ceylon and Burma
6. Smith, M.A. 1941. The fauna of British India, Ceylone and Burma including the whole of the Indo-Chinese sub-Chinese sub-region. Taylor and Francis, London.

9. MEDICAL PARASITOLOGY

Unit – I :

1. Introduction to parasites of man, scope and definition of parasites/parasitology
2. Protozoa :
 - 2.1. General characters of parasitic protozoa
 - 2.2. Morphology, life cycle and pathogenicity of *Entamoeba histolytica*, *Giardia*, *Trichomonas Naeglaria*
 - 2.3 Haemoflagellates : *Trypanosoma*, *Leishmania*
 - 2.4 Apicomplexa : *Plasmodium*, Differential diagnosis : *Toxoplasma Pneumocystis*

Unit – II :

3. Trematodes :
 - 3.1. General characters and classification of digenetic trematodes
 - 3.2. Identification characters, life cycle, pathogenicity and control of human parasitic, digenetic trematodes : *Chlonorchis sinensis*, *Paragonimus westermani* and *Schistomes*

Unit – III :

4. Cestodes :
 - 4.1. General characters and classification of cestodes
 - 4.2. Larval cestodes pathogenic to man
 - 4,3, Identification characters, life cycle, pathogenicity and control of *Diphyllobothrium latum*, *Taenia solium*, *T. saginata*, *Hymenolepis nana*

Unit – V :

5. Nematodes :

5.1. General characters of Nematodes

5.2. Identification, life cycle, pathogenecity and control of *Ascaris lumbricoides*, *Enterobius vermicularis*, *Ancylostoma duodenale*

5.3. Filarid worms : *Wuchereria bancrofti* and *Brugia malayi*

5.4. *Trichinella spiralis* and *Trichiuris trichiura*.

Practical :

1. Smear preparation for protozoa
2. Preparation of whole mounts for helminths
3. Spotters based on theory

Suggested Reading Material :

1. Manson's Tropical disease by Cook
2. Concepts and Principles of Epidemiological studies
3. Parasitology in Focus

10. VETERINARY PARASITOLOGY

Unit – I :

- 1.0. Introduction to parasitism : Scope and definition
- 2.0. Protozoa : Classification of parasitic protozoa
 - 2.1. Parasites of fishes : Myxozoa, Microsporidia and Haemogregarina
 - 2.2. Parasites of poultry : *Histomonas*, *Eimeria tenella* and *Haemoproteus* and *Leucocytozoan*
 - 2.3. Parasites of cattle : *Babesia* and *Theileria*

Unit – II :

- 3.0. Trematodes : Classification of trematodes
 - 3.1. Morphology, life cycle, pathogenicity and control of *Fasciola*, *Paramphistomum*, *Cotylophoron*, *Paragonimus*, *Dicrocoelium* and *Schistosoma*

Unit – III :

Cestodes : Classification of cestodes up to orders

- 4.1. Morphology, life cycle, pathogenicity and control of *Moniezia*, *Echinococcus*, *Dipylidium*, *Spirometra*
- 4.2. Larval cestodes of veterinary animals of human importance

Unit – IV :

- 5.0. Nematodes : Classification of parasitic nematodes
 - 5.1. Morphology, life cycle, pathogenicity and control of *Haemonchus*, *Oesophagostomum*, *Toxocara*, *Trichiurus*, *Bunostomum*, *Ancylostoma*
- 6.0. Ticks and mites of domestic animals

Practical :

1. Representative examples of protozoa and helminth parasites of birds and domestic animals
2. Preparation of wet and dry smears
3. Host examination for parasites
4. Stool examination and identification of ova

Suggested Reading Material :

1. Levine, N.D., Textbook of veterinary protozoology
2. Parasitology in Focus.

11. PRINCIPLES OF IMMUNOLOGY

Unit – I

1. Scope and definition of Immune system
 - a) Cells and organs of immune system, structure and organization of the lymphoid organs
2. Immune Response :
 - a) Primary (b) Secondary immune response
3. Types of Immunity
 - a) Innate immunity (b) Acquired immunity

Unit – II :

4. Antigens
 - a) Antigens (b) Haptens (c) Epitopes (d) Adjuvants
 - e) Antigenic determinants (f) Immunogenicity Antigenicity
5. Antibodies
 - a) Structure and function (b) Classes and sub-classes
 - c) Antibody diversity (d) Effector functions

Unit – III :

6. Antigen and antibody reactions
 - a) Precipitation reactions (b) Agglutination reactions
 - c) ELISA (d) Immuno Electrophoresis

Unit – IV :

7. Major histo compatibility complex
 - a) HLA systemic hormones (b) MHC Haplotypes

- c) Class I and II MHC molecules (d) Diversity and expression of MHC
8. Organization and expression of Ig genes
- 8.1. Models for Ig gene structure
 - 8.2. Multiple organization
 - 8.3. Generation of antibody diversity

Practical :

1. Immune system in Birds and Mice : Dissection and location of organs
2. Histology of Thymus, Spleen, Liver and Bursa
3. Antigen – Antibody reaction : Immunodiffusion, Agglutination, Precipitation
4. Serum Analysis : Estimation of serum proteins, Albumin, Globulin and Glucose levels

Suggested Reading Material :

1. Roitt, I.M. Essentials of Immunology
2. Kuby. Immunology
3. Wier. Immunology : An outline of Medicine and Biology
4. Nandini Shetty. Immunology

IV SEMESTER

(B) STREAM – ELECTIVES

1. METABOLIC CELL FUNCTION AND REGULATION

Unit – I :

- 1.0. Thermodynamic principles and steady-state conditions of living organisms
 - 1.1. Organization and methods to study metabolism
- 2.0. Degradation of glucose, palmitic acid, phenylalanine

Unit – II :

- 3.0. Energy metabolism and high energy compounds
 - 3.1. Redox potentials
 - 3.2. Mitochondrial electron transport chain
 - 3.3. Oxidative phosphorylation
- 4.0. Storage and utilization of biological energy
 - 4.1. Biosynthesis of Urea, Glucose, Glycogen, Oleic acid and prostaglandins

Unit – III :

- 5.0. Nature of Enzymes
 - 5.1. Classification and nomenclature of enzymes
 - 5.2. Kinetic analysis of enzyme catalysed reactions
- 6.0. Metabolic profile of adipose, neural, hepatic, and muscle tissues

Unit – IV :

- 7.0. Metabolic Engineering
- 8.0. Immobilized enzymes and their applications

Practical :

1. Enzyme kinetics
2. Dehydrogenase
3. Lactic acid estimation
4. Proteins, glucose and Lipid estimations
5. DNA, RNA estimation
6. Transaminases

Suggested Reading Material :

1. Voet, D. and J.G. Voet. Biochemistry. J. Wiley & Sons
2. Foster, R.L. Nature of Enzymology
3. Lodish et. al. Molecular Cell Biology
4. Annual Reviews of Biochemistry
5. Garrett and Grisham. Biochemistry.

2. ENVIRONMENTAL PHYSIOLOGY

Unit – I

1.0. Environment

- 1.1 Freshwater environment – Types and limiting factors – Biota – Temperature O₂
- 1.2 Marine environment – Zonation - limiting factors – Biota – Temperature Oxygen, Salinity, nutrients, light etc
- 1.3. Estuarine environment – limiting factors – Biota – Temperature, Oxygen
- 1.4. Terrestrial environment – Factors – Biota – Temperature – Oxygen, light etc

Unit – II

2.0 Respiratory Pigments

- 2.1 Distribution and Chemistry of respiratory pigments
- 2.2 Transport of gases by haemoglobin, Oxygen and carbondioxide
- 2.3 Haemoglobin in Invertebrates
- 2.4 Functions of Haemocyanins, Chlorocruorin and hemerythrin.

3.0 Nutrition

- 3.1 Nutrition types
- 3.2 Carbon and Nitrogen requirements
- 3.3 Amino acid requirements
- 3.4 Special dietary requirements of some animals

4.0. Digestive Physiology.

- 4.1. Physiology of Digestion in vertebrates – role of enzymes and hormones, factors affecting absorption of nutrients from the alimentary canal

Unit – III

- 5.0 Specialized sensory organs
 - 5.1 Lateral line sense organs
 - 5.2 Electric organs
 - 5.3 Electroreception
 - 5.4 Bioluminescence
 - 5.5 Chromatophores

Unit – IV

- 6.0 Receptor Physiology
 - 6.1 Mechanoreception
 - 6.2 Photoreception
 - 6.3 Phonoreception
 - 6.4 Chemoreception
 - 6.5 Equilibrium receptors
 - 6.6 Receptor mechanisms

Practical :

1. Effect of body size Vs. oxygen consumption
2. Oxygen consumption Vs. temperature
3. Osmotic regulation
4. Ion concentration measurements
5. Water quality- hardness, alkalinity, salinity, pH, turbidity.

Suggested Reading Material :

1. Eckert, R. Animal Physiology: Mechanism and Adaptation. W.H. Freeman and Company, New York.
2. Hochachka, P.W. and Somero, G.N. Biochemical adaptation. Princeton, N.J.
3. Hoar, W.S. General and comparative Animal Physiology. Princeton Hall of India.
4. Schiemdt Nielsen. Animal Physiology. Adaptation and Environment, Cambridge.
5. Strand, F.L. Physiology: A regulatory systems approach. Macmillan Publishing Co., New York.
6. Punmer, L. Practical Biochemistry. Tata McGraw Hill.
7. Prosser, C.L., Environmental and Metabolic Animal Physiology. Wiley-Liss Inc., New York.
8. Wilson, K. and Walker, J. Practical Biochemistry.
9. Wilmer, P. J. Stone and I. Johnson. Environmental Physiology. Blackwell Sci. Oxford, UK, 944 pp.
10. Newell R. C. (ed.), 1976. Adaptation to environment. Essays on the physiology of marine mammals. Butterworths, London, UK, 539 pp.
11. Townsend, C.R. and P. Calow. Physiological Ecology. An evolutionary approach to resource use. Blackwell Sci. Publ. Oxford, UK.
12. Dejours, P.L. Boils, C. R.. Taylor and E.R. Welbel (eds.). Comparative Physiology. Life in water and on land, Liviana Press, Padova, Italy.
13. Johnston, I.A. & A.F. Bennett (eds.). Animals and Temperature, Phenotypic and evolutionary adaptation. Cambridge Univ. Press, Cambridge, UK.
14. Louv, G.N. Physiological animal ecology. Longman Harlow, UK.

3. PRINCIPLES OF BIOTECHNOLOGY

Unit – I :

1. Concepts of Biotechnology : Scope and importance. Biotechnology in India
2. Recombinant DNA and gene cloning : Cloning and expression vectors Chimeric DNA. Gene Libraries

Unit – II :

3. Polymerase chain reaction (PCR)
4. Gene amplification : Basic PCR and its modifications, Applications of PCR in Biotechnology and genetic engineering

Unit – III :

5. Animal cell and tissue culture : Laboratory facilities, culture media and procedures, primary culture, cell lines, cloning tissue and organ culture
6. Biotechnology in Medicine : animal and human health care, genetic counseling, forensic medicine

Unit – IV :

7. Biotechnology and Environment : Pollution control environment and energy, biodiversity and conservation
8. Biotechnology and intellectual property :
 - 8.1. Intellectual Property Rights (IPR)
 - 8.2. Intellectual Property Protection (IPP)

Practical :

1. Determination of DNA, RNA, Glucose, Proteins and Lipids. Polyacrylamide gel electrophoresis (PAGE), Southern Blotting and Northern Blotting. PCR demonstration.

Suggested Reading Material :

1. Gupta, P.K. Elements of Biotechnology
2. Singh, B.D. Biotechnology
3. Balasubramanian. Concepts in Biotechnology

4. TOXICOLOGY

Unit – I :

- 1.0. General principles of Toxicology
 - 1.1. Introduction and History
 - 1.2. Areas of Toxicology
 - 1.3. Toxic dose tolerance
 - 1.4. Risk and safety
 - 1.5. Routes and sites of transportation

Unit – II :

- 2.0. Toxic effects of pesticides
 - 2.1. Environmental contamination
 - 2.2. Routes of exposure
 - 2.3. Organophosphates
 - 2.4. Acetyl cholinesterase inhibition and reversal
 - 2.5. Organochlorines
 - 2.6. Carbamates
- 3.0. Toxic effects of metals
 - 3.1. Estimation of dose-effect relationships
 - 3.2. Factors influencing toxicity of metals
 - 3.3. Carcinogenesis

Unit – III :

- 4.0. Neurotoxicity
 - 4.1. Selective vulnerability
 - 4.2. Sites of neurotoxic action
 - 4.3. Axonopathy

4.4. Myelinopathy

5.0. Immunotoxicity

5.1. The immune system

5.2. Methods of detection of immunotoxicity

5.3. Immunotoxic agents

Unit – IV :

6.0. In Vivo testing and safety evaluation

6.1. A summary of good laboratory practices (GLP)

6.2. Animal care procedures

Practical :

1. Effect of metals (heavy metals) and pesticides on oxygen consumption of fish, evolution of LC₅₀ values by probit method
2. In Vitro effect of metals on ATPases and Pesticides and Acetyl Cholinesterases

Suggested Reading Material :

1. Marguis, J.K. A guide to General Toxicology
2. Casseret & Doull. Toxicology : The basic series of poisons
3. Robert G. Tardiff and Joseph V. Rodricks. Toxic substances and human risk.
4. Ernest Hodgson and Patricia Levi. Modern Toxicology.

5. APPLIED IMMUNOLOGY

Unit – I :

1.0. Immuno-diagnostic techniques and their applications

1.1 Radioimmuno assay, ELISA, Immuno precipitation, Immuno-florescence, Western Blotting.

1.2 Hybridoma technology – Production of monoclonal antibodies and their applications

2.0. Vaccines

2.1. Active and passive Immunization

2.2. Designing vaccines

2.3. Whole organism vaccines

2.4. Polysaccharide vaccines, Toxoid vaccines, Recombinant Antigen vaccines, DNA vaccines, Recombinant vector vaccines, Synthetic peptide vaccines

Unit – II :

3.0. Hypersensitivity Reactions

3.1. Gell and combs classification

IgE mediated (Type I) Hypersensitivity

Antibody mediated cytotoxic (Type II) Hypersensitivity

Immune complex mediated (Type III) Hypersensitivity

TDTH mediated (Type IV) Hypersensitivity

4.0. Immune Response to Infectious Diseases

4.1. Viral infections (Influenza)

4.2. Bacterial infections (Diphtheria, Tuberculosis)

4.3. Protozoan Diseases (Malaria)

4.4. Helminth Diseases (Schistosomes and Filaria)

Unit – III :

5.0. Immuno-deficiency Diseases

5.1 Primary immuno deficiencies – Defects in Lymphoid lineage (SCID, Immune disorders involving thymus and selective deficiencies of Ig classes)

Defects in Myeloid lineage

Defects in complement system

Treatment of Immuno deficiency

5.2. Secondary Immuno deficiencies - AIDS

6.0. Auto Immunity

6.1 Organ – specific auto immune diseases

6.2 Systemic Auto immune diseases

6.3 Treatment of Auto immune diseases

Unit – IV :

7.0. Transplantation Immunology

- 7.1. Immunologic basis of graft REJECTION
- 7.2. Clinical manifestation of graft rejection
- 7.3. GVHD
- 7.4. Immuno suppressive therapy

8.0. Cancer and the Immune system

Cancer : Origin and Terminology
Malignant transformation of cell
Tumor Antigens
Immune Response to tumors
Tumor evasion
Cancer Immuno-therapy

Practical :

1. Preparation of inoculation
2. Immunization – Collection of blood and separation of anti-serum
3. Cell Viability test (Trypan blue dye exclusion test)
4. Outcherlony Double Diffusion (for antibody titration)
5. Single Radial Immuno Diffusion
6. Immuno electrophoresis
7. Western Blotting (Demonstration)
8. Tumors - Slides

Suggested Reading Material :

1. Kuby. Immunology
2. Roit. Essentials of Immunology
3. Weir. Immunology
4. Abbas

6. MEDICAL MICROBIOLOGY

Unit – I :

- 1.0. Introduction to Microbiology
 - 1.1. Scope and History of Microbiology
 - 1.2. Characterization and classification of Micro-organisms
 - 1.3. Identification of Micro-organisms
- 2.0. Bacterial Disease Agents - I
 - 2.1. Aerobic gram –ve rods, *Pseudomonas, Bordetella*
 - 2.2. Aerobic gram +ve cocci, *Neisseria*
 - 2.3. Facultative anerobic gram negative rods. *Escherichia coli, Solmonella, Shigella, Vibrio*
 - 2.4. Facultative anerobic gram +ve cocci

Unit – II :

- 3.0. Bacterial Disease Agents - II
 - 3.1. Spore-forming gram +ve Bacilli – *Bacillus anthracis, Clostridium*
 - 3.2. Non-spore forming gram +ve Bacilli. *Corynebacterium, Mycobacteria*
- 4.0. Viruses as Human Pathogens - I
 - 4.1. Adeno virus : Respiratory diseases
 - 4.2. Herpes virus : Herpes simpler
 - 4.3. Retrovirus : AIDS / HIV
 - 4.4. Rhabdovirus : Rabies

Unit – III :

- 5.0. Viruses as Human Pathogens - II

- 5.1. Nomenclature and definition of hepatitis viruses
 - 5.2. Structure and composition
 - 5.3. Hepatitis virus infections
- 6.0. Fungal infection of Man
- 6.1. Cutaneous mycoses
 - 6.2. Endemic mycoses

Unit – IV :

- 7.0. Opportunistic infections
- 7.1. Candidiasis, Aspergillosis
- 8.0. Antibiotic and other chemotherapeutic agents
- 8.1. Drug resistance in bacteria
 - 8.2. Drug resistance in other microbes.

Practical :

1. Preparation of basic culture media for bacteria
2. Inoculation and identification of bacteria
3. Representative slides for all groups of organisms

Suggested Reading Material :

1. Pelzar Jr., Chan & Krieg, N.E. Microbiology. V Edn. Tata McGraw Hill
2. Cook. Microbial life. Modern Biology Series. Sistrorn Mansons, Tropical Diseases

6. HAEMATOLOGY

Unit – I :

1.0. Blood

1.1. Terminology

1.2. Structure

1.3. Chemistry

1.4. Blood plasma, Plasma proteins (Albumin and Globulin, Fibrinogen) and enzymes

1.5. Functions of blood

2.0. Classification of blood cells

Unit – II :

3.0. Origin and differentiation of haematopoietic cells

4.0. Blood groups

4.1. ABO system and RH system

4.2. Blood coagulation, blood clotting factors and inhibitors of clotting

Unit – III :

5.0. Blood corpuscles under normal condition

6.0. Blood corpuscles under abnormal condition

6.1. Genetic anomalies

- 6.2. Reactive changes
- 6.3. Primary changes
- 6.4. Polyploidy

Unit – IV :

- 7.0. Diseases of blood and changes of blood due to diseases
- 8.0. Diseases of red cells
- 9.0. Diseases of white cells
 - 9.1. Neoplastic proliferation of white cells- lymphomas, leukemias and myelomas
- 10.0. Techniques and methods of blood and bone marrow examination

Practical :

- 1. Preparation of thin and thick smears
- 2. Staining techniques
- 3. Differential and total counts
- 4. Estimation of percentage haemoglobin, serum, protein and blood glucose
- 5. Erythrocyte sedimentation rate (ESR)

Suggested Reading Material :

- 1. Sandog Atlas of Haematology
- 2. Principles of Haematology
- 3. Pathological basis of disease by Robbin
- 4. Textbook of Pathology by Harsha Mohan.

7. GENERAL AND SYSTEMIC PATHOLOGY

Unit – I :

1.0. Cellular injury and cell death

- 1.1. Cause of cell injury
- 1.2. Sub-cellular alterations and inclusions in cell injury
- 1.3. Cellular adaptations
- 1.4. Cell death – Necrosis and Apoptosis

2.0. Inflammation and repair

- 2.1. Acute inflammation
- 2.2. Chronic inflammation
- 2.3. Wound healing

Unit – II :

3.0. Neoplasia

- 3.1. Characterization of malignant neoplasms
- 3.2. Clinical features of tumor
- 3.3. Carcinogenic agents
- 3.4. Grading and staging of tumors
- 3.5. Laboratory diagnosis of cancer – histologic and cytologic methods

Unit – III :

4.0. Systemic Pathology

- 4.1. Heart : Ischemic and rheumatic heart disease

5.0. Lung :

- 5.1. Obstructive pulmonary disease – Emphysema, Chronic bronchitis and Asthma
- 5.2. Pulmonary infection – Pneumonia and Tuberculosis

Unit – IV :

6.0. Gastrointestinal tract

- 6.1. Malignant tumors of oesophagus, stomach, small and large intestine
- 6.2. Appendix – Acute appendicitis
- 6.3. Liver – Viral hepatitis & Cirrhosis
- 6.4. Pancreas – Pancreatitis and Diabetes mellitus

Practical :

- 1. Preparation of preservatives
- 2. Fixation of tissues
- 3. Section cutting
- 4. Staining by Haematoxylin
- 5. Staining by histochemical stain, BPB, PAS
- 6. Examination of tissue sections – normal and diseased permanent slides

Suggested Reading Material :

- 1. Pathological basis of diseases by Robins.
- 2. Cells, Tissues and diseases by Guido Majno and Isabeller Jons.
- 3. Textbook of Pathology by Harsha Mohan.

